

CLAIMS

WE CLAIM:

- 5 1. An adapter for coupling a sensor to a fluid line (having at least a first opening) therein, the adapter comprising:
- an adapter block having a first fluid channel, a first input port, and a first output port;
- a retainer plate coupled to the adapter block, the retainer plate having at least a
- 10 first opening therethrough; and
- a first diaphragm having a first membrane portion and a first rim portion surrounding the first membrane portion, the first membrane portion positioned within the retainer plate first opening and the rim portion positioned between at least the adapter block and the retainer plate,
- 15 wherein the first diaphragm is held in place by a compression force exerted between the adapter block and the retainer plate.
2. The adapter of Claim 1, further comprising:
- a first spacer element coupled within the first output port, the first spacer
- 20 element having a second fluid channel including a second input port and a second output port, the second input port in fluid communication with the first fluid channel and the second output port adapted for coupling with a sensor.
3. The adapter of Claim 1, further comprising:
- 25 a second fluid channel, a second input port, and a second output port formed in the adapter block;
- a second opening formed through the retainer plate; and

a second diaphragm having a second membrane portion and a second rim portion surrounding the second membrane portion, the second membrane portion positioned within the retainer plate second opening and the second rim portion positioned between at least the adapter block and the retainer plate,

5 wherein the second diaphragm is held in place by a compression force exerted between the adapter block and the retainer plate.

4. The adapter of Claim 3, further comprising:

10 a second spacer element coupled within the second output port, the second spacer element having a third fluid channel including a third input port and a third output port, the third input port in fluid communication with the second fluid channel and the second output port adapted for coupling with a sensor.

15 5. The adapter of Claim 1, wherein the first diaphragm is formed of the same material as the adapter block.

6. The adapter of Claim 5, wherein:

20 the first membrane includes a plurality of convolutions on one or more surfaces thereof.

7. The adapter of Claim 3, wherein the second diaphragm is formed of the same material as the adapter block.

8. The adapter of Claim 3, wherein:

25 the second membrane includes a plurality of convolutions on one or more surfaces thereof.

9. The adapter of Claim 1, wherein the first diaphragm is formed of different material than the adapter block.
- 5 10. The adapter of Claim 3, wherein the second diaphragm is formed of different material than the adapter block.
11. The adapter of Claim 1 wherein:
the fluid line includes a fluid input port and a fluid output port and a flow bore extending from the fluid input port to the fluid output port.
- 10 12. The adapter of Claim 11 wherein:
the flow bore of the fluid line includes an integral flow orifice.
13. The adapter of Claim 11 wherein:
15 the flow bore of the fluid line includes an integral flow venturi.
14. The adapter of Claim 11 wherein:
the bore of the fluid line is a substantially straight bore.
- 20 15. The adapter of Claim 1 wherein:
the one or more membranes includes a plurality of convolutions on one or more surfaces thereof.
- 25 16. An adapter for coupling a sensor to a fluid line having at least a first opening therein, the adapter comprising:
an isolator block having at least a first cavity and a second cavity formed therein, the second cavity adapted for fluidly coupling to the first opening in the fluid line; and

a first membrane integrally formed as part of the isolator block and physically separating the first cavity from the second cavity.

17. An adapter for coupling a sensor to a fluid system, comprising:

a fluid line including a fluid input port, a fluid output port, and a flow bore extending from the fluid input port to the fluid output port, the fluid line further including at least a first opening extending from the flow bore to a surface thereof;

an isolator block having at least a first cavity and a second cavity formed therein, the second cavity adapted for fluidly coupling to a first opening in the fluid line; and

a first membrane integrally formed as part of the isolator block and physically separating the first cavity from the second cavity.

18. An adapter for coupling a sensor to a fluid line having at least a first opening therein, the adapter comprising:

an isolator block having at least a first cavity and a second cavity formed therein, the second cavity adapted for fluidly coupling to the first opening in the fluid line;

a first membrane integrally formed as part of the isolator block and physically separating the first cavity from the second cavity; and

a first spacer element having one or more openings extending therethrough from a first surface to a second surface, the first spacer element coupled within the first cavity such that one of its first and second surfaces is positioned proximate the first membrane.

19. The adapter of Claim 18 wherein:

the first membrane is integrally molded with the isolator block.

20. The adapter of Claim 18 wherein:
the first membrane is integrally machined into the isolator block.
21. The apparatus of Claim 18 wherein:
the first membrane includes a plurality of convolutions on one or more
surfaces thereof.
22. The adapter of Claim 18 wherein:
the fluid line includes a fluid input port and a fluid output port and a flow bore
extending from the fluid input port to the fluid output port.
23. The adapter of Claim 22 wherein:
the flow bore of the fluid line includes an integral flow orifice.
24. The adapter of Claim 22 wherein:
the flow bore of the fluid line includes an integral flow venturi.
25. The adapter of Claim 22 wherein:
the flow bore of the fluid line is a substantially straight bore.
26. The adapter of Claim 18 wherein:
another one of the first and second openings of the first spacer element is a fill
port for inserting a pressure transmission fluid.
27. The adapter of Claim 18, further comprising:
a third cavity and a fourth cavity formed in the isolator block, the fourth
cavity adapted for fluidly coupling to a second opening in the fluid line; and

a second membrane integrally formed as part of the isolator block and physically separating the third cavity and the fourth cavity.

28. The adapter of Claim 27 wherein:

5 the second membrane is integrally molded with the isolator block.

29. The apparatus of Claim 27 wherein:

the second membrane is integrally machined into the isolator block.

10 30. The adapter of Claim 27 wherein:

the second membrane includes a plurality of convolutions on one or more surfaces thereof.

31. The adapter of Claim 27, further comprising:

15 a second spacer element having one or more openings extending therethrough from a third surface to a fourth surface, the second spacer element coupled within the third cavity such that one of its third and fourth surfaces is positioned proximate the second membrane.

20 32. An adapter for coupling a sensor to a fluid system, comprising:

a fluid line including a fluid input port, a fluid output port, and a flow bore extending from the fluid input port to the fluid output port, the fluid line further including at least a first opening extending from the flow bore to a surface thereof;

25 an isolator block having at least a first cavity and a second cavity formed therein, the second cavity adapted for fluidly coupling to a first opening in the fluid line;

a first membrane integrally formed as part of the isolator block and physically separating the first cavity from the second cavity;

a first spacer element having one or more openings extending therethrough from a first surface to a second surface, the first spacer element coupled within the first cavity such that one of its first and second surfaces is positioned proximate the first membrane; and

5 a sensor in fluid communication with one of the openings in the first spacer element.

33. The adapter of Claim 32 wherein:
 the first membrane is integrally molded with the isolator block.

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34. The adapter of Claim 32 wherein:
 the first membrane is integrally machined into the isolator block.

35. The adapter of Claim 32 wherein:
15 the first membrane includes a plurality of convolutions on one or more surfaces thereof.

36. The adapter of Claim 32 wherein:
 the sensor comprises a pressure sensor.

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37. The adapter of Claim 32 wherein:
 the fluid line includes a fluid input port and a fluid output port and a flow bore extending from the fluid input port to the fluid output port.

25 38. The adapter of Claim 37 wherein:
 the flow bore of the fluid line includes an integral flow orifice.

39. The adapter of Claim 37 wherein:

the flow bore of the fluid line includes an integral flow venturi.

5 40. The adapter of Claim 37 wherein:

the flow bore of the fluid line is a substantially straight bore.

41. The adapter of Claim 32 wherein:

10 another one of the first and second openings of the first spacer element is a fill port for inserting a pressure transmission fluid.

42. The adapter of Claim 32, further comprising:

15 a third cavity and a fourth cavity formed in the isolator block, the fourth cavity adapted for fluidly coupling to a second opening in the fluid line; and a second membrane integrally formed as part of the isolator block and physically separating the third cavity and the fourth cavity.

43. The adapter of Claim 42 wherein:

20 the second membrane is integrally molded with the isolator block.

44. The adapter of Claim 42 wherein:

the second membrane is integrally machined into the isolator block.

45. The adapter of Claim 42 wherein:

25 the second membrane includes a plurality of convolutions on one or more surfaces thereof.

46. The adapter of Claim 42, further comprising:

a second spacer element having one or more openings extending therethrough from a third surface to a fourth surface, the second spacer element coupled within the third cavity such that one of its third and fourth surfaces is positioned proximate the second membrane,

wherein the sensor is in fluid communication with one of the openings in the second spacer element.

47. An apparatus for sensing one or more physical characteristics of a fluid, comprising:

a fluid line including a fluid input port, a fluid output port, and a flow bore extending from the fluid input port to the fluid output port, the fluid line further including a first opening and a second opening spaced apart from the first opening, each of the first and second openings extending from the flow bore to a surface thereof

an isolator block having at least a first cavity, a second cavity, a third cavity and a fourth cavity formed therein, the second cavity and fourth cavity each adapted for fluidly coupling to the first opening and a second opening, respectively, in the fluid line;

a first membrane integrally formed as part of the isolator block and physically separating the first cavity from the second cavity;

a second membrane integrally formed as part of the isolator block and physically separating the third cavity from the fourth cavity;

a first spacer element having one or more openings extending therethrough from a first surface to a second surface, the first spacer element coupled within the first cavity such that one of its first and second surfaces is positioned proximate the first membrane;

a second spacer element having one or more openings extending therethrough from a third surface to a fourth surface, the second spacer element coupled within the third cavity such that one of its third and fourth surfaces is positioned proximate the second membrane; and

5 a sensor in fluid communication with one of the openings in the first spacer element and in fluid communication with one of the openings in the second spacer element.

48. An adapter for coupling a sensor to a fluid system, comprising:

10 a fluid line having a first and a second opening;

an isolator plate having one or more cavities formed therein adapted for fluidly coupling to the first and second openings in the fluid line;

at least one membrane integrally formed as part of the isolator plate and positioned proximate one end of the cavity;

15 an adapter plate coupled to the isolator plate, the adapter plate having a first fluid channel having a first input port in fluid communication with the membrane and a first output port;

a first spacer element coupled within the first output port, the first spacer element having a second fluid channel including a second input port in fluid
20 communication with the first fluid channel and a second output port adapted for coupling with a sensor.

49. The adapter of Claim 48 wherein:

25 the fluid line includes a fluid input port and a fluid output port and a flow bore extending from the fluid input port to the fluid output port.

50. The adapter of Claim 49 wherein:

the flow bore of the fluid line includes an integral flow orifice.

51. The adapter of Claim 49 wherein:

the flow bore of the fluid line includes an integral flow venturi.

5 52. The adapter of Claim 49 wherein:

the bore of the fluid line is a substantially straight bore.

53. The adapter of Claim 48 wherein:

the at least one membrane is integrally molded with the isolator plate.

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54. The adapter of Claim 48 wherein:

the at least one membrane is integrally machined into the isolator plate.

55. The adapter of Claim 48 wherein:

15 the at least one membrane includes a plurality of convolutions on one or more surfaces thereof.

56. An adapter for coupling a sensor to a fluid line having at least a first opening therein, the adapter comprising:

20 an isolator plate having at least a first cavity adapted for fluidly coupling to a first opening in the fluid line;

at least a first membrane integrally formed as part of the isolator plate, the first membrane positioned proximate one end of the first cavity;

25 an adapter plate coupled to the isolator plate, the adapter plate having a first fluid channel having a first input port in fluid communication with the first membrane and a first output port;

a first spacer element coupled within the first output port, the first spacer element having a second fluid channel including a second input port in fluid

communication with the first fluid channel and a second output port adapted for coupling with a sensor.

57. The adapter of Claim 56 wherein:

5 the fluid line includes a fluid input port and a fluid output port and a flow bore extending from the fluid input port to the fluid output port.

58. The adapter of Claim 57 wherein:

10 the flow bore of the fluid line includes an integral flow orifice.

59. The adapter of Claim 57 wherein:

the flow bore of the fluid line includes an integral flow venturi.

60. The adapter of Claim 57 wherein:

15 the bore of the fluid line is a substantially straight bore.

61. The adapter of Claim 58 wherein:

the at least one membrane is integrally molded with the isolator plate.

62. The adapter of Claim 56 wherein:

20 the at least one membrane is integrally machined into the isolator plate.

63. The adapter of Claim 56 wherein:

25 the at least one membrane includes a plurality of convolutions on one or more surfaces thereof.

64. An apparatus for sensing one or more physical characteristics of a fluid, comprising:

an isolator plate having at least a first cavity formed therein adapted for fluidly coupling to a first opening in a fluid line and a second cavity formed therein adapted for fluidly coupling to a second opening in the fluid line ;

at least a first membrane integrally formed as part of the isolator plate and positioned proximate one end of the first cavity and at least a second membrane integrally formed as part of the isolator plate and positioned proximate one end of the second cavity;

an adapter plate coupled to the isolator plate, the adapter plate having a first fluid channel having a first input port in fluid communication with the first membrane and a first output port, the adapter plate including a third fluid channel having a third input port in fluid communication with the second membrane and a third output port;

a first spacer element coupled within the first output port, the first spacer element having a second fluid channel including a second input port in fluid communication with the first fluid channel and a second output port;

a second spacer element coupled within the third output port, the second spacer element having a fourth fluid channel including a fourth input port in fluid communication with the third fluid channel and a fourth output port adapted for coupling with the sensor; and

a sensor in fluid communication with the second output port and the fourth output port.